Water

P.E.I.'s MOST PRECIOUS RESOURCE

GROUNDWATER RESOURCES EVALUATION

ALBERTON

THE CANADA – PRINCE EDWARD ISLAND
WATER MANAGEMENT AGREEMENT

Environment Canada Environnement Canada

Prince Edward Island
Department of the Environment

GROUNDWATER RESOURCES EVALUATION

ALBERTON

92-07511/

Groundwater Resources Evaluation - Alberton

Executive Summary

A review of the available hydrogeological data for the Alberton area was conducted document the current status of groundwater resources in the community. The results of this investigation indicate that the current demands for water are adequately met by existing on-site servicing, and that groundwater quality is generally good.

An analysis of available pump test data from the region indicates a reasonable potential for the development of high capacity wells and virtually all wells in the area are capable of meeting ordinary domestic requirements. In spite of the proximity to several saltwater bodies, saltwater intrusion does not appear to be a particular problem.

The level of development in the Town of Alberton is such however, that while there have been few significant instances of groundwater contamination to date, the continued quality of groundwater cannot be guaranteed.

Public awareness of the potential threats to groundwater can play an important role in the preservation of this resource particularly in the areas of handling and storage of hazardous materials including petroleum products and in proper well construction practices. The identification and protection of areas suitable for the development of a central water supply would be a worthwhile investment in order to keep future water supply options open.

Acknowledgments

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1. Introduction

This report documents the findings of a study of the groundwater resources of the Community of Alberton, conducted as part of the Groundwater Resource Evaluation Project, under the Canada - Prince Edward Island Water Management Agreement. The purpose of the this project is to investigate, through a series of studies, the available groundwater resources in selected communities across the Island and to make recommendations regarding the most appropriate manner of developing and protecting this resource, in light of the physical constraints and expected water needs of each community.

2. Geography

2.1 Physical geography

Alberton is located at the western end of Prince Edward Island, 130 km from Charlottetown. The community is situated near the northern portion of Cascumpec Bay. Surface relief is gently undulating, with the West Lake Creek (Kildare River.) , Alberton Creek and Dock Creek forming most of the southern and eastern boundary of the community. Maximum elevations are in the range of 23 m in the northern part of the community, and most of the community is at elevations between 8 and 15 m above sea level.
There are some low-lying, swampy areas , especially along the creeks.

2.2 Cultural Geography

The Town of Alberton covers an area of 4.53 Km^2 and according to the 1986 Census had a population of 1103 and has a population density of 243.5 persons per Km^2. Primary (farming fisheries and forestry) and service industries account for the bulk of economic activity in the community.

3. Geology

3.1 Surficial Geology

Overburden in the Alberton area consists of primarily of sandy glaciomarine deposits, with minor silt and clay, and sand phase ground moraine, The glaciomarine deposits occupying a narrow (800 m) zone East of main street and south of Church Street, which occupy a zone about 800 m wide east of Main street and south of Church Street, (Prest,1973). Pockets of

glaciomarine sand are found in other areas within the town as well. From previous information (Pollitt, 1951), and the stratigraphic logs on the Well Drillers Reports, overburden thickness averages 3.5m.

The soil survey report (MacDougal and Veer, 1981) indicates soils in this area are primarily Alberry series, which is coarse and moderately coarse textured, (less than 8% clay), strongly acid ground moraine developed on undulating relief, with good surface drainage, good subsoil permeability (greater than 1 x 10-4 cm/sec) and deep water tables, The southern and eastern areas or the town are underlain by dominantly by Kildare series soils which are coarse textured, acid glaciomarine deposits developed on level relief, with rapid surface drainage, and rapid subsoil permeability. The Mossy Point series is also represented and is derived from moderately coarse textured, stratified glaciomarine deposits on level topography, and is typified by poor to very poor surface drainage , good subsoil permeability and very shallow water tables.

3.2 Bedrock Geology

Bedrock consists of Upper Pennsylvanian to Lower Permian sedimentary strata of Megacyclic Sequence II (van de Poll, 1981). These consist of red conglomerate, sandstone and siltstone, generally becoming coarser with depth, with the basal conglomerate overlying conformably the sandstone and siltstone of Megacyclic Sequence I. The environment of deposition of these deposits is believed to be fluvial in origin, and it is expected that the stratigraphy is characterized by rapid lateral facies changes associated with recurring cycles of fluvial sedimentation. Well Drillers Reports indicate predominantly sandstone, with some siltstone and claystone.

4. Hydrogeology

4.1 Well Data and Aquifer Characteristics

The P.E.I. Department of the Environment has well drillers records for nearly 200 wells constructed since 1970 in the Alberton area. Well depths average 21 m with a maximum depth of 37 m for domestic wells (Two wells 91 m deep were constructed for Alberton Fisheries in 1970 and 1971)and a minimum depth of just 9 m. Casing lengths average 9.1 m with a maximum of 22 m and a minimum of 3.7 m.

Static water levels reported on the well drillers reports average 5.8 m below ground level, ranging from as shallow as 0.6 m to as much as 15 m below ground. Some of the static water level data is somewhat suspect however as it suggests static water levels below sea level. Since the near by Cascumpec Bay should effectively act as a constant head boundary in the area, static water levels should not be below mean sea level (except perhaps under pumping conditions). It

is likely that some of these measurements were made immediately after bailing of the well, before complete recovery has been achieved, there by over estimating the depth to the water table.

The data are compatible with average water table elevations which may not be much above sea level, which would be expected in an area of comparatively low relief near the sea.

Average well yields as reported on the well drillers reports average 0.68 litres per second (L/sec.) and range from .38 L/sec to 5.3 L/sec. The value of 5.3 L/sec. is for one of the deep production wells at Alberton Fisheries, and all other reported well yields were 1.5 L/sec. or less.

Two points should be borne in mind when evaluating this well yield data; most of these yield evaluations are based on short duration (5 to 10 minute) bail tests, and secondly, the apparent well yields reported in the area could be a reflection of the demand for water as much as a function of aquifer characteristics (ie. unless large volumes of water were sought, drillers would be expected to complete wells at depths at which domestic water requirements are met.)

To make more meaningful the well yield data from the well drillers reports, the well depth or more precisely the saturated portion of the aquifer penetrated by individual wells must be taken into account. As is common on P.E.I., individual aquifers are often difficult to identify, especially as the flow of water through fractures is probably more significant than primary porosity in determining hydraulic conductivity (Francis, 1981). For these reasons the entire saturated thickness of sediments penetrated by well can be approximated as a single semi- confined aquifer.

All other factors being equal, a deeper well with a greater depth of open hole below the water table would be expected to yield a greater quantity of water than a shallower well. To evaluate the water yielding characteristics of the aquifer then, it is useful to take into account the saturated thickness (water bearing portion) of each well when considering well yield.

As a measure of aquifer yield then, the yield per metre of saturated thickness penetrated, for each well has been calculated. The distribution of yields per metre (L/sec./m) of saturated thickness for the Alberton are is shown on Figure 1. As the figure shows the majority of wells have yields per saturated thicknesses in the range of 0.05 and .06 L/sec./m. This would mean that on average a well 30 m deep with a static water level of 12 m would be expected to yield approximately 1 L/sec.

Frequently on the Island there is a reasonable correlation between well depth and yield per saturated thickness, with deeper wells generally showing higher absolute yields, but not in proportion to the increased saturated thickness penetrated by the well. This is generally at

Figure 1

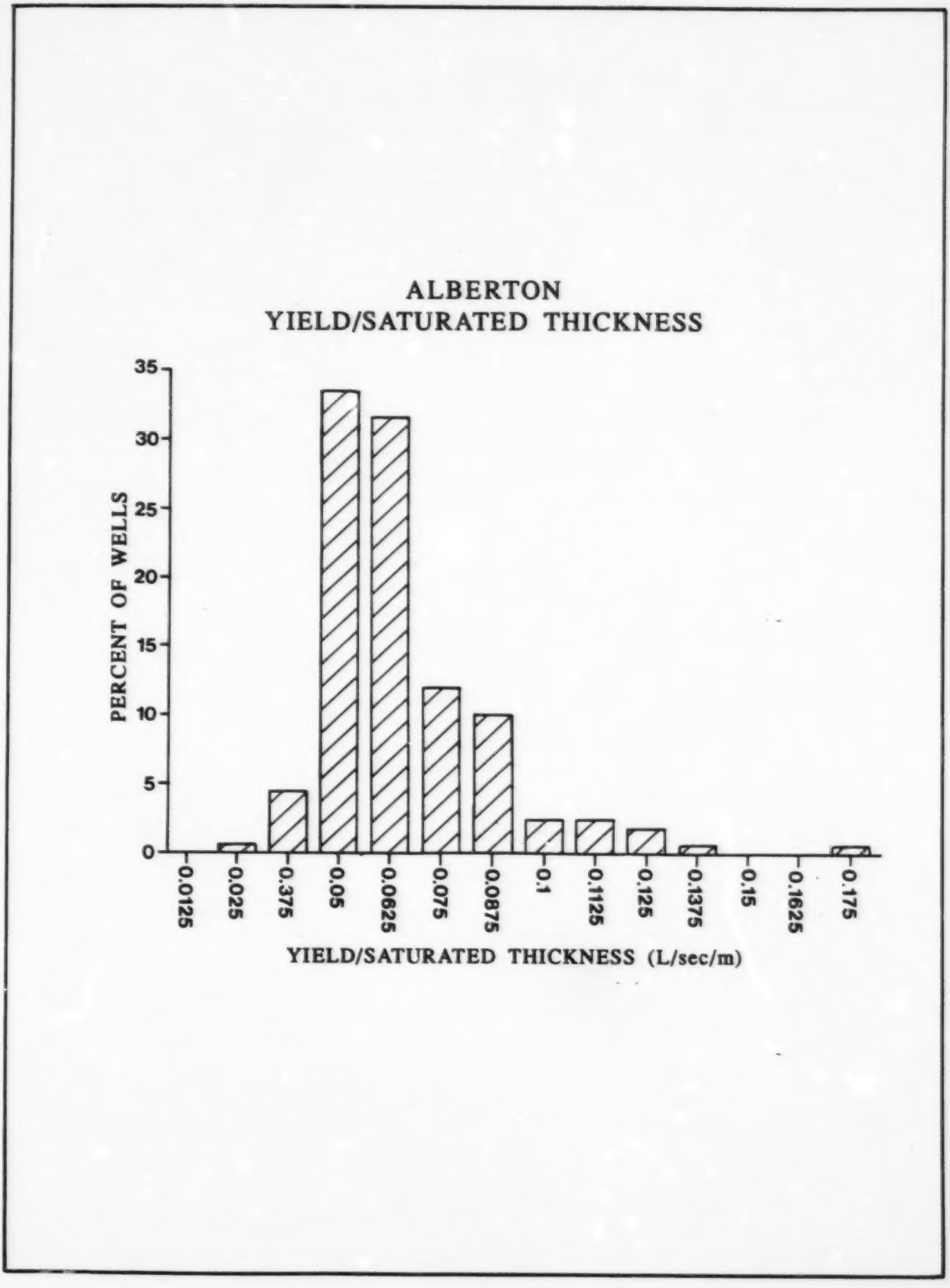
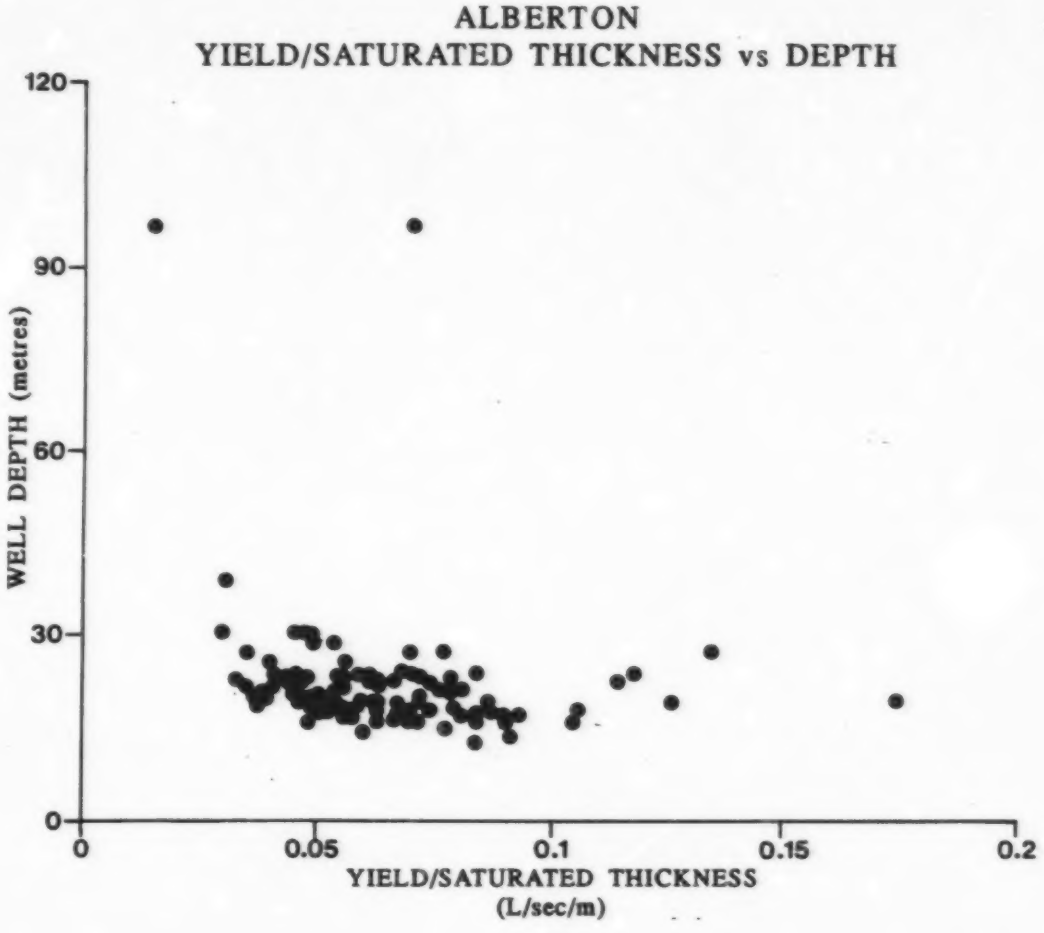

ALBERTON
YIELD/SATURATED THICKNESS
PERCENT OF WELLS
35
30
25
20
15
10
5
0
0.0125
0.025
0.375
0.05
0.0625
0.075
0.0875
0.1
0.1125
0.125
0.1375
0.15
0.1625
0.175
YIELD/SATURATED THICKNESS (L/sec/m)

Figure 2


ALBERTON
YIELD/SATURATED THICKNESS vs DEPTH
WELL DEPTH (metres)
120
90
60
30
0
0
0.05
0.1
0.15
0.2
YIELD/SATURATED THICKNESS
(L/sec/m)

tributed to a decrease in the frequency and size of water bearing fractures with depth (Francis, 1981). As noted above fracture flow is the more significant than intergranular flow in most Island aquifers, and is the primary determinant of hydraulic conductivity, thus deeper wells suffer from a diminishing return, in terms of well yield, with increased depth.

Such a correlation is only weakly demonstrated by the data available for Alberton. Figure 2 shows a plot of well depth vs. yield per saturated thickness for approximately 190 wells in the Alberton area, although part of the reason for this may be in good part because of the relatively restricted range of well depths in the community. Nonetheless it is interesting to note that one of the two deeper wells drilled for Alberton Fisheries has a yield per saturated thickness of 0.068 L/sec/m - just slightly above the average range found in the community.

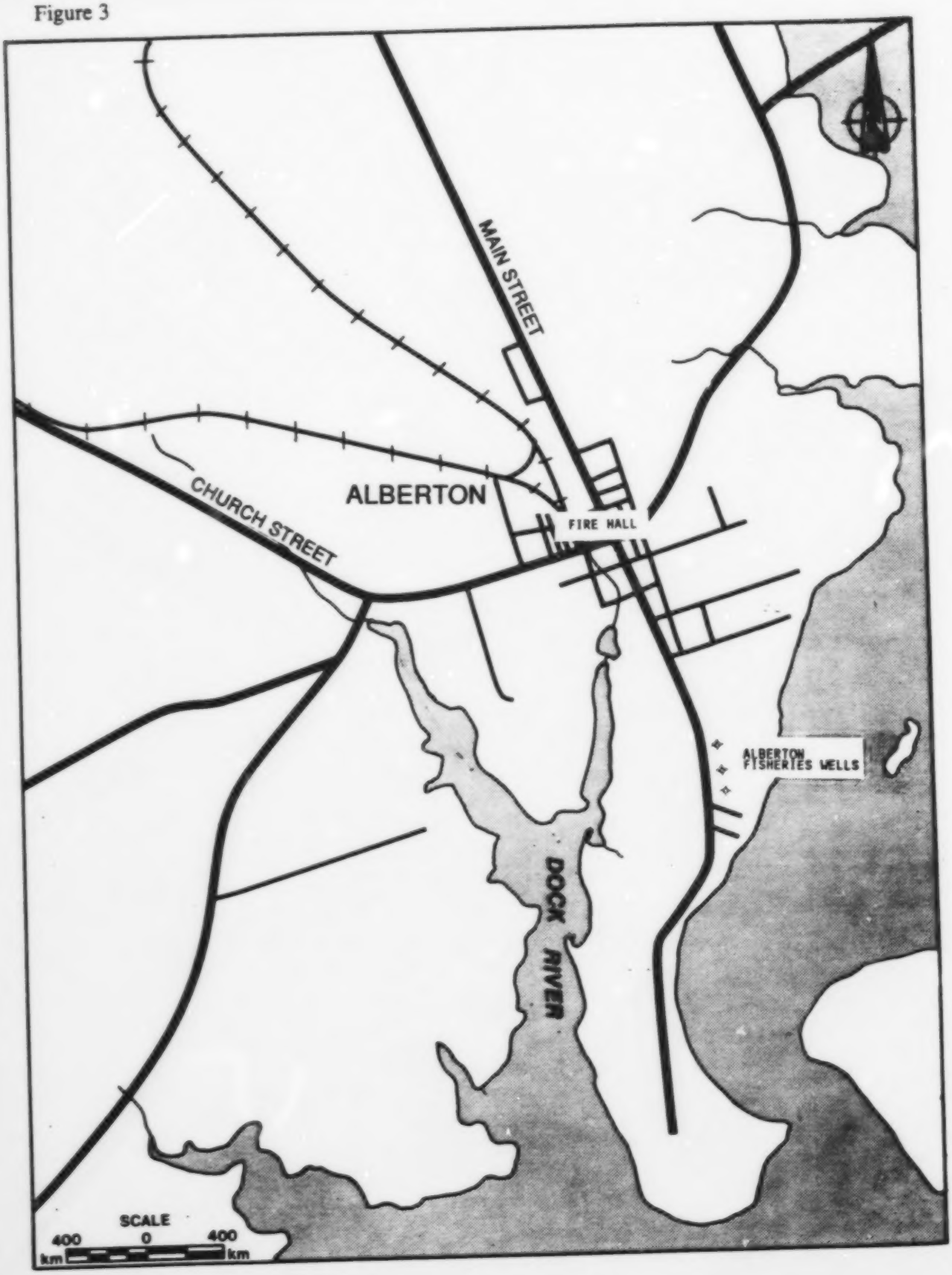
In addition to the information from well drillers reports, there have been several pump tests conducted on wells within the community, with varying degrees of sophistication. Figure 3 indicates the location of test wells for two of these tests, one at the Alberton Fire Hall and one several wells just south of the Town owned by Alberton Fisheries.

A pump test was carried out in 1968 on the well at the Alberton Fire Hall. This well was 61 metres deep, with a diameter of 15 cm and a static water level of 2.1 m. Although details of the test are poorly documented it appears that the well is capable of sustaining pumping rates in the range of 10 to 15 L/sec. It was apparently pumped at a rate or 11.4 l/s for at least 2 hours, and then at 15.8 L/s for as much as a further 16 hours. Drawdown during the 11.4 L/sec. pumping rate was 4 m and at 15.8 L/sec. was 13.1 m. The specific capacities for these two pumping stages are 2.85 and 1.21 litres per second per metre of drawdown respectively. (Specific capacity is a measure associated with the relationship between pumping rate and drawdown in a well).

Although strictly speaking these two specific capacities should not be compared without considering the duration of the pumping stage at the same time, they indicate that the well is capable of sustaining considerable flow rates, although the rather marked decrease in specific capacity leads one to speculate that during the second pumping stage well losses due to turbulent flow were becoming a much more significant component of total drawdown.

Pump testing was also carried out in 1968 for Alberton Fisheries, located just south of the town. For these pump tests 2 production wells had been drilled approximately 350 m apart. PW1 was 91 m deep, 15 cm in diameter, and had 10.7 m of casing. In addition a 30 m deep observation well was constructed half way between the two wells. Three 24 hour constant rate pump tests were conducted with PW1 being pumped at 3.8 L/sec, PW2 being pumped at 5.3 L/sec and finally both wells being pumped simultaneously at 3.8 and 5.3 L/sec. respectively.

Figure 3


MAIN STREET
CHURCH STREET
ALBERTON
FIRE HALL
ALBERTON FISHERIES WELLS
DOCK RIVER
SCALE
400 0 400
km km

It was concluded from the test data that the transmissibility of the aquifer was in the range of 135 m^2/day and the storativity coefficient of the aquifer was in the range of 2.5×10^{-4}. (Transmissibility is a measure of how readily water is transmitted through the aquifer under a given hydraulic gradient and the storativity coefficient is a measure of the amount of water released form storage per unit decline in hydraulic head.)

These results suggest that these wells should be capable of sustaining yields considerably in excess of the rates at which they were tested, perhaps in the range of 10 to 15 L/sec., although without any step drawdown data, especially at these higher pumping rates, it is difficult to extrapolate beyond the rates at which the well was tested. It is possible that well losses may become excessive at higher pumping rates and a that pumping water levels in production wells would limit the available flow, even though the aquifer was capable of sustaining greater yields.

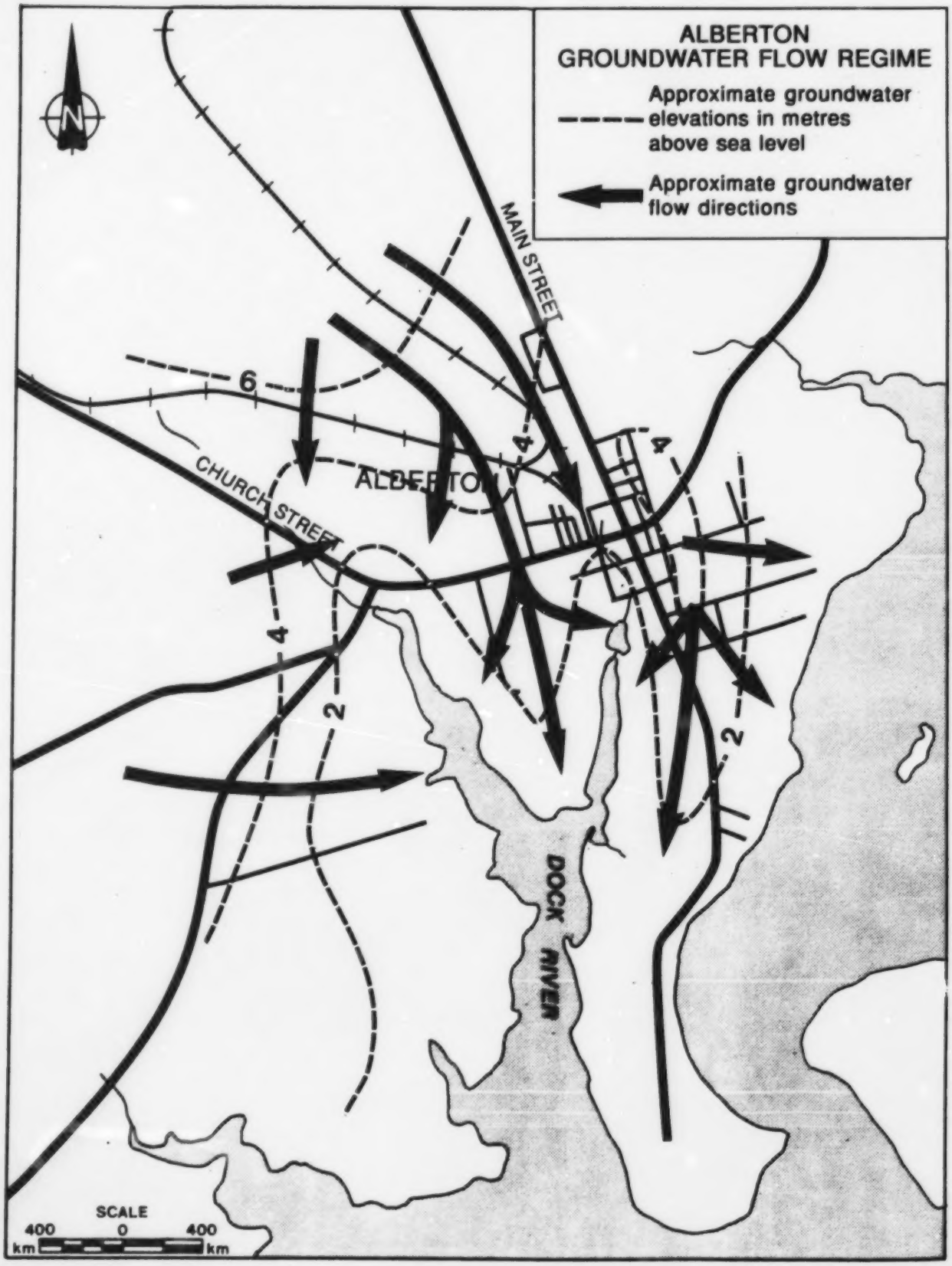
4.2 Groundwater Flow Regime

With the available data it is difficult to describe the configuration of the groundwater flow regime in Alberton with any great degree of reliability. The static water level data indicated on well drillers reports are somewhat suspect, and in addition have been collected at different times of the year over a period of nearly two decades and thus incorporate a considerable degree of temporal variability (ie. water levels in any given well are expected to reflect seasonal changes as well as variations from year to year).

Finally, the available well data provide some information about the local flow regime at at depth of 20 to 30 m, but may not reflect conditions at shallower depths, thus making if difficult to determine the effect of local topography on the flow regime. Like wise information at greater depths is also lacking making speculation about the regional aspects of the hydrogeology difficult as well. Fortunately surface water divides and groundwater divides are generally the same on P.E.I., thus local hydrogeologic regimes can be delineated on the basis of surface water basins (Francis, 1989).

By combining information from the well data with the topographic configuration of the watershed it is possible to draw some general conclusions regarding the directions of groundwater flow in the area and the probable hydraulic gradients. Figure 4 is an attempt to integrate these considerations into a highly schematic picture of the local hydrogeologic flow system showing expected groundwater flow directions and water table elevations. In light of the nature of the static water level caution should be exercised particularly in relation to the groundwater elevation contours - they are intended to represent probable relative water table elevations and are based on a highly subjective assessment of the available information.

Figure 4


ALBERTON
GROUNDWATER FLOW REGIME
Approximate groundwater elevations in metres above sea level
Approximate groundwater flow directions
N
MAIN STREET
CHURCH STREET
ALBERTON
6
4
4
4
2
2
DOCK RIVER
SCALE
400 0 400
km km

The data indicate maximum water table elevations in the Alberton area probably do not exceed 8 m above sea level and in most cases are probably in the range of 4 to 6 m above sea level, being higher towards the north and away from surface water bodies. A substantial portion of the community, particularly in areas adjacent to Dock Creek, and Alberton Creek probably have water table elevations of less than 2 m above sea level.

Groundwater flow directions area expected to be dominantly north to south on a regional scale, deflecting towards Dock Creek and Alberton Creek further to the south of the towards Alberton Harbour to the east. The existence of the small groundwater "high" centered in the Central Street area is speculative and only weakly supported by the static water level data.

Hydraulic gradients are expected to be shallow, and probably only rarely exceed 1%. In southern portions of the community gradients may be as low as 0.6%.

5. Groundwater Quality

5.1 Baseline Groundwater Quality

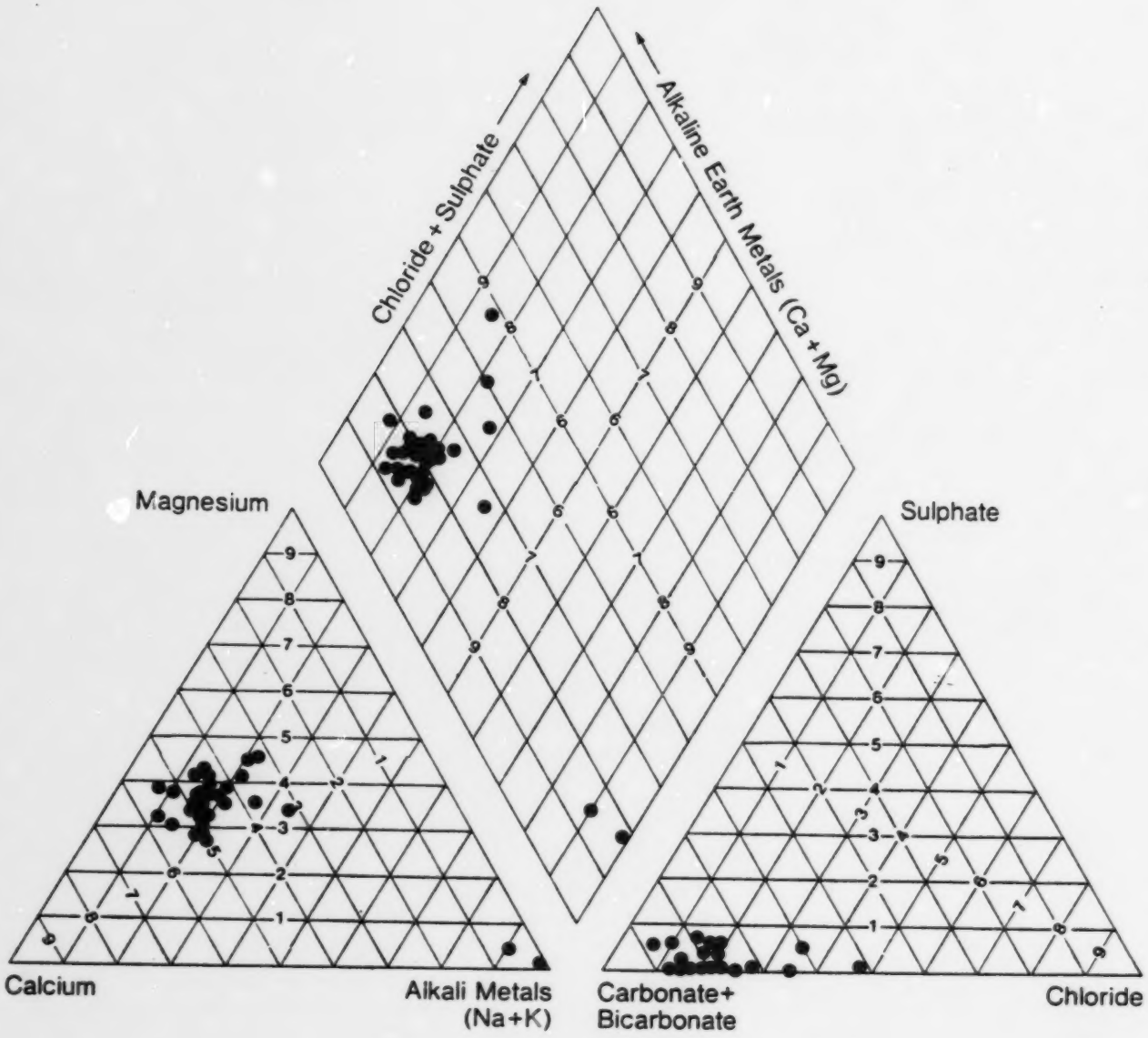
Water Quality analyses from the files of the P.E.I. Department of the Environment indicate that groundwaters in the area are typical of the calcium - bicarbonate type waters found elsewhere in the western portion of P.E.I. The water is generally moderately hard with neutral to slightly alkaline pH. Other than the sporadic occurrence of elevated iron and manganese concentrations, natural water quality in the community is good. These occurrences of elevated iron and manganese concentrations pose no health threat and are for the most part randomly distributed through out the community although they are more frequent in the northern part of town. Somewhat surprisingly the occurrence of salt water intrusion appears to be conspicuously absent from the area, considering the low elevation and hydraulic gradients and proximity to a number of salt water bodies. The distribution of the major ionic species for groundwater samples from the town are shown on a Piper diagram on Figure 5.

5.2 History of Water Quality Problems

The Town of Alberton has generally been fortunate with regard to water quality problems. As noted above natural groundwater quality problems consist of isolated cases of high iron and manganese concentrations. In addition to this there have been only two significant instances of groundwater contamination documented in the community, both involving hydrocarbon spills.

The most serious incident involved a spill of about 10,000 L of gasoline from the ESSO service station near the intersection of Albion and Church Streets between January 1974 and May 1975, and resulted in the contamination of 4 nearby wells. In the second incident the fuel oil

Figure 5


Chloride + Sulphate
Alkaline Earth Metals (Ca + Mg)
Magnesium
Sulphate
Calcium
Alkali Metals
(Na+K)
Carbonate+
Bicarbonate
Chloride

tank at the Hospital was found to be leaking and may have lost up to 2000 litres of fuel oil. Approximately 120 m^3 of contaminated soil were removed from the site, and no wells have been affected by the incident.

5.3 Potential Threats to Groundwater Quality

Alberton has been fortunate in having relatively few water quality problems in the past and a recognition of some of the potential threats to groundwater quality can be an important component of efforts to ensure the continued quality of water in the area.

Probably the most common threat to groundwater quality on Prince Edward Island is contamination by petroleum products from leaking underground storage tanks. The Town of Montague has already been the site of a few of these incidents, and it is only realistic to expect that other spills will occur in the future. Therefore groundwater in the immediate vicinity around service stations or other locations where significant quantities of petroleum products are stored is probably at some risk of contamination. It is worth mentioning also that while large underground petroleum storage tanks perhaps pose a greater risk to groundwater resources when taken individually, because of their numbers, domestic home heating oil tanks have statistically account for a significant portion of contamination events.

There a couple of areas in the community where past or present land use practices could lead to concerns over high nitrate concentrations. One of these areas is the vicinity of the race track on the west side of town, while the other is site of the sewage lagoon. While there is no evidence of elevated nitrate levels in these locations at this time, any site where a concentration of human or animal wastes is likely there is the potential for elevated nitrate levels in groundwater. In the both cases however the presumed direction of groundwater flow is away from developed parts of the community and the degree of risk is probably quite low.

The Town of Alberton is serviced by a central sewer system, and problems with bacterial contamination of wells appears to be relatively rare. Overburden in the area is quite permeable however, making wells particularly susceptible to contamination from near surface sources, and proper maintenance of sewer lines is important.

Finally, although posing only an indirect threat to water quality in the community, the very source of water itself (individual wells) may be as much a reason for concern as many of the more direct and obvious hazards affecting water quality. Because of the reliance on - site water supplies, there is the likelihood that general water quality will gradually decline over time. Each well (particularly poorly constructed wells) represents a discreet pathway for water, and any potential contaminants it may carry, from the near surface environment to portions of the aquifer from which water supplies are developed. While the impact of each well individually, may be virtually negligible, cumulatively the influence of such a great density of wells will inevitably alter conditions in the subsurface environment including groundwater quality.

6. Planning Considerations

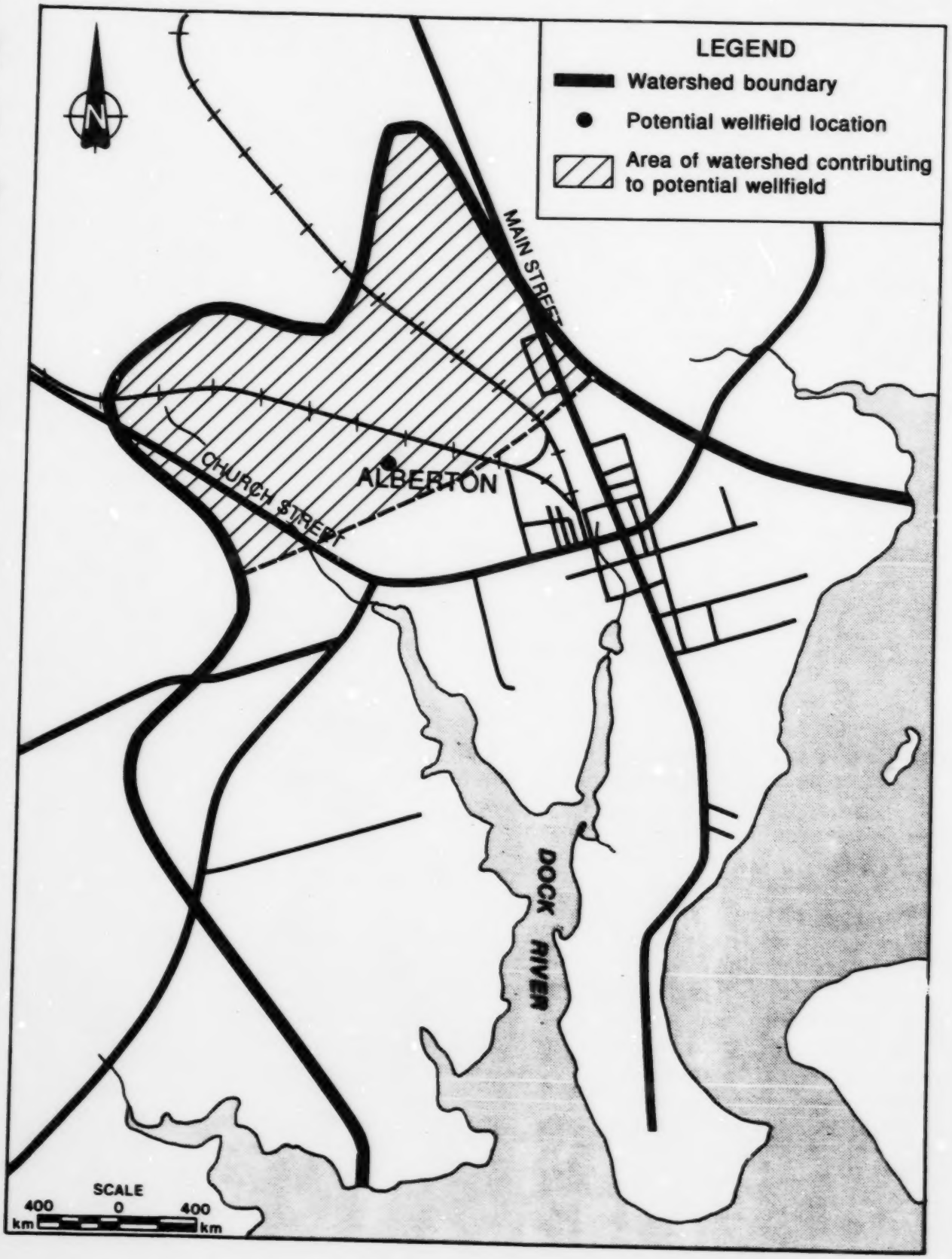
6.1 Availability of Groundwater

A review of the available data indicates that the current water supply needs of the Town of Alberton are adequately met by existing on-site water supplies (ie. private wells) and that groundwater quality in the area is generally not a constraint to water supply development.
With a population of just over 1,100 the average daily water requirements for the Town are probably in the range of 300 m^3/day or 3.8 L/sec. (based on a per capita consumption of 0.27 M^3/day. Peak flow requirements might be expected to be three times this amount or 11.4 L/sec. There are relatively few high capacity wells developed in the area, but pump test data from the well at the Fire Hall and just outside of Town at Alberton Fisheries suggest that good potential exists for wells yielding in the range of 10 L/sec., sufficient to meet the requirements of a central water supply if central servicing were considered for the community.

No specific potential well filed locations were investigated in the course of this study, however based on the available hydrogeological information and expected land use patterns, the area to the north west of the center of the Town as shown on Figure 6 is suggested for consideration as it is hydrogeologically "up stream" from the center of development, reducing the risk of groundwater contamination and it is in an area where effective well field protection measures could be implemented.

When considering any area for the development a water supply which will involve substantial groundwater withdrawals, it is important to ensure that the area under consideration can support the required level of pumping with out creating adverse effects on other water users. This includes not only the possible effects on other wells in the vicinity but also any impact on the contribution of groundwater to surface water flows.

Figure 6


LEGEND
Watershed boundary
Potential wellfield location
Area of watershed contributing to potential wellfield
N
MAIN STREET
CHURCH STREET
ALBERTON
DOCK RIVER
SCALE
400 km
0
400 km

In Prince Edward Island surface water divides and groundwater divides are generally thought to coincide (Francis, 1989), allowing the delineation of hydrogeological regimes into systems based on surface watershed extent. The level of groundwater withdrawal possible without adverse impacts to other water users is a function of the areal extent of the watershed contributing water to the well field, and can be based on the amount of available recharge. Figure 6 also outlines the watershed area in which this potential well field might be located and the area of the watershed which would be expected to contribute water to the well field (approximately 2.5 km^2.

For the purposes of this report it can be assumed that up to 50% of the available recharge may be safely withdrawn without adversely affecting stream flows in the area. Typical recharge rates on the Island are in the range of 35 % of annual precipitation which averages 1100 mm. Using these assumptions the amount of water potentially available at this site has been calculated as approximately 1300 m^3/day. The anticipated demand for the Town is only 23% of this figure (300 m^3/day), thus this area would be capable of supporting a considerable increase in water demand in the future.

6.2 Groundwater protection strategies

The importance of groundwater resources to the health and welfare of the Island communities is well recognized. To a lesser extent, the importance of implementing sound, far sighted strategies aimed at protecting this valuable resource is also appreciated. The following discussion attempts to provide some focus to the issue, by presenting some possible approaches to the development of a comprehensive groundwater protection strategy.

The issue of groundwater protection can be separated into two components: specific recommendations for the protection of central water supply wells or well fields; and general considerations pertinent to the establishment and operation of on - site water supplies and protection and preservation of groundwater resources in general.

It is worth commenting at this point that even if a community has no intention of developing a central water supply in the foreseeable future (and indeed, such a consideration may not be appropriate to the development plans of a community), it is highly desirable to consider this possibility, and to be aware of the requirements and constraints involved in the development of a central water supply. This exercise ideally would involve the identification of suitable locations for the development of such a supply and appropriate strategies to preserve the resource for future use.

Well field protection

Unlike the processes that lead to the contamination of surface water bodies, the degradation of groundwater resources is not subject to direct observation, and consequently more difficult to predict, correct and avoid. Once contaminants have been introduced into a groundwater system, their migration and fate is governed by a complex series of reactions and processes which depend on a number of parameters which may be only poorly documented . Consequently the prediction of the consequences of the introduction of contaminants into a groundwater reservoir in the vicinity of wells supplying a water supply system requires a number of approximations and assumptions of varying validity.

A number of approaches have been developed to provide varying degrees of protection to the wells supplying central water supply systems. In general, the object of these strategies is to designate a given area around the well or well field for which activities which have the potential to impact on the integrity of the water supply are regulated or prohibited.

"The major parameters in developing groundwater protection strategies for municipal water wells are legal, socio-economic and hydrogeological" (Allan Gregory, 1988), In this report suggested protective strategies are based primarily on hydrogeological parameters. It is recognized that the modification of these strategies in light of socio-economic factors is an inevitable and desirable aspect of the development of appropriate strategies for individual communities.

There are a variety of techniques which have been employed to define the extent of various groundwater protection zones. Three types of zones are considered in this report are defined below.

1) Radius of Influence - The areal extent of the cone shaped depression of the water table or piezometric surface, resulting from the pumping of water from a well or well field. Within this area it is recommended that no residential , commercial or industrial development takes place, and that restrictions be placed on agricultural activities. The area would be suitable however for the development of some types of recreational activities.

2) 60 day Delay Time Zone - Given information on the direction and magnitude of the hydraulic gradient and the aquifer characteristics, it is possible to estimate the velocity of groundwater or a contaminant towards a well under pumping conditions. The 60 day delay time zone represents the area within which a potential contaminant could migrate to the well within a 60 day period.

It is recommended that within this area, on - site sewage disposal systems, (i.e. septic systems), and the storage or handling of hazardous chemicals (including petroleum products) be prohibited. In addition any development proposals should be subjected to an environmental impact assessment, at least in regard to their potential impact on the integrity of the water supply system.

3) Catchment Area - A zone outlining the area in which groundwater is expected to flow to the well or well field, both under pumping conditions and under the existing natural hydrogeological flow regime. Within this area major development proposals or proposed land use changes should be subjected to an environmental impact assessment.

Each of these approaches has its strengths and weaknesses, and it is perhaps advisable to develop well field protection measures which incorporate aspects of each approach. Without a specific site and information on the aquifer characteristics at that site it is difficult to define definitively the extent of any of these zones. However by using values for these aquifer parameters derived from the pump testing at Alberton Fisheries, some indication of the size of these zones can be given. At the least this will provide an appreciation for the order of magnitude of these zones, and hopefully providing information for planning purposes. At such time as a well field is developed, a more refined estimate, based on site specific information, can be developed.

It should be noted however, that even with site specific data, some of these parameters exhibit temporal variability (eg. recharge to the aquifer) while others may show spatial variability (eg. hydraulic conductivity of the aquifer), thus certain simplifying assumptions usually must be made in any event.

As a basis for the determination of the extent of these zones, certain simplifying assumptions must be made such as the pumping rate from individual wells, the local topography, and the aquifer characteristics in the vicinity of the well field. It will be assumed here that the average daily water requirements (extracted from a single well) will be in the range of 300 m^3/day (approximately 3.8 L/sec.) and that pumping will be continuous with no recharge to the aquifer for a period of 180 days.

The transmissibility of the aquifer will be assumed to be 135 m^2/day and the storage coefficient will be taken as 2.5×10^{-4}. Effective porosity of the aquifer will be assumed to be 1%. Finally it will be assumed that the well field is developed in an area where the slope of the water table (ie. hydraulic gradient) will be 1%.

With this information, the areal extent of a series of hypothetical well head protection zones can be estimated. In practice of course, more than well is likely to be required (particularly to meet peak demand, as well as providing a backup supply to the system in the event of mechanical failure or contamination of one of the supply wells.

Radius of influence:

When water is being pumped from a well, the water table is depressed in the surrounding area, creating a change in the hydraulic gradient towards the well. This cone shaped depression is commonly referred to as the "cone of depression" or the "radius of influence" of the well.

Various techniques can be employed to estimate the extent of this area, which will depend on the duration and rate of pumping, aquifer characteristics, and other hydrogeological parameters. Because from a theoretical standpoint, the areal extent of the cone of depression may in fact be infinite, some practical boundary must be assumed. For the purposes of this study, the radius of influence will be defined as the point at which the hydraulic gradient induced by pumping is less than or equal to the natural hydraulic gradient (ie, at a distance at which it is difficult to distinguish the effects of pumping on the natural flow system.

For a well pumping under the circumstances outlined above the radius of influence would be expected to be a slightly elliptical area, extending approximately 250 m in an up slope direction and 100 m in a down slope direction and perpendicular to the slope.

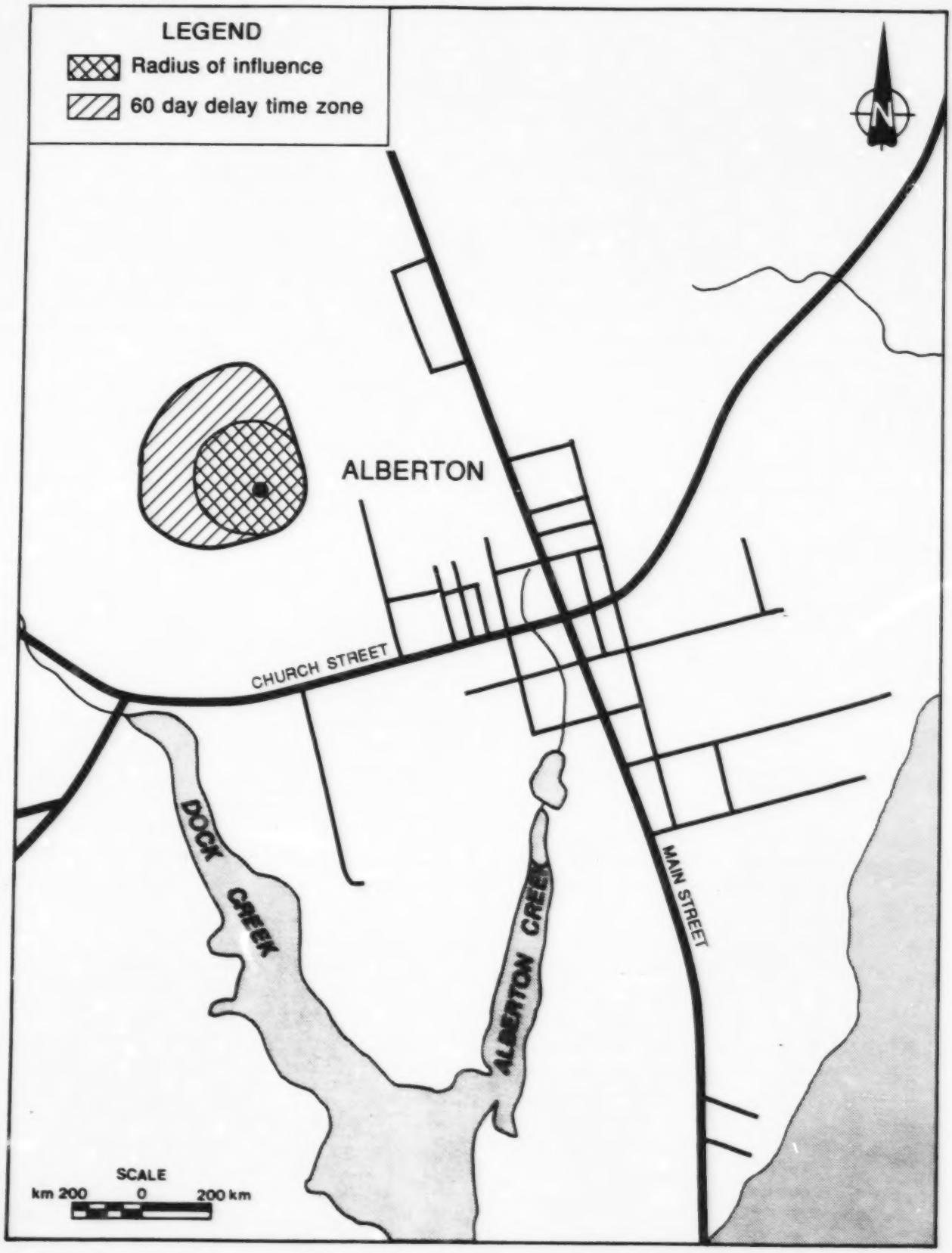
Delay Time Zone:

The rate at which contaminants can travel towards a well is a function of a number of factors, including the nature of the aquifer materials, the natural hydraulic gradient, and the hydraulic gradient induced by pumping. As might be expected the higher the pumping rate, the more rapidly a contaminant can be expected to migrate towards the well. A 60 day delay time zone should provide protection from most pathogenic organisms (60 days is the maximum time most pathogens are believed to survive in groundwater), and could also provide a sufficient buffer zone that an alternative well location could be sought if a particularly serious incident of contamination threatened the water supply.

Thus for instance, if a spill of a hazardous material occurs at the boundary of this zone, the community would have approximately 60 days before the contaminant was expected to reach the well, in which to take whatever remedial or corrective action was possible.

Based on the assumptions outlined above, such a zone would have an up slope extent of approximately 360 m and a down slope extent of 75 m. While the up slope extent of this zone may seem surprisingly large, it should be noted that under the same circumstances, groundwater would travel approximately 270 m in the same 60 days under the natural hydraulic gradient alone. Perpendicular to the slope, the extent of this zone would be approximately 100 m in each direction from the well.

Figure 7


LEGEND
Radius of influence
60 day delay time zone
N
ALBERTON
CHURCH STREET
DOCK CREEK
ALBERTON CREEK
MAIN STREET
SCALE
km 200 0 200 km

Catchment Area:

Without site specific information it is not impossible to define the extent of this zone. The down slope extent of the zone would be expected to be the same as for the delay time zone in most cases, and the up slope direction will generally be the point at which some significant topographic divide. If a well field were developed in the area shown on Figure 6 this area would probably extend to the watershed boundary shown to the north of the proposed well filed location to the southern extent of the radius of influence or delay time zone. The approximate extent of these zones based on the above assumptions is shown on Figure 7.

7. Conclusions and Recommendations

The results of these investigations indicate that the current water supply needs of the Town of Alberton are adequately met by existing on-site servicing, and the community is fortunate in being able to rely on these supplies for good quality water. Typical well yields are more than adequate to meet domestic requirements and pump test data from the few high capacity wells in the area suggest reasonable potential exists for well field development should central water servicing be considered in the future. Natural groundwater quality in the region is good and to date there have been relatively few incidences of significant groundwater contamination in the community.

Experience on the Island and elsewhere suggests that with the level of development and the density of individual private wells in the community, some degradation of water quality can be expected over time. Public awareness of the potential threats to groundwater quality, including a recognition of the importance of proper well cosntruction and safe handling and storage of hazardous materials (including petroleum products)will help preserve existing groundwater quality.

At some point in the future the community may determine that the provision of water by a central water supply system is either necessary or desirable. The identification and protection of a land base capable of supporting the development of a central well field now, would be a wise investment against the day that such a supply is developed.

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APPENDIX I

WATER WELL DATA

APPENDIX I, WATER WELL DATA
ALBERTON

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Clayton Oliver	721011	416200	5185300	70	80	23	24	5	15	0–6 Clay till 6–70 Fractured sandstone	32 60
Campbell Roger	800617	416200	5185000	75	75	29	31	5	10	0–12 Sandy till 12–75 Claystone, fractured sandstone	35 40 55 65
Hudson Dale	800604	416500	5183900	80	80	30	29	5	5	0–4 Clay 4–80 Sandstone and claystone	31 34 45 48
Campbell Erwin	800616	416300	5185800	80	75		31	20	10	0–8 Sandy till 8–80 Claystone, fractured sandstone	35 40 60 65
Campbell William	800617	416400	5185900	85	75	21	30	15	15	0–9 Sandy till 9–85 Claystone and sandstone	40 50 75 80
Adams Gerald	790611	416800	5184000	85	75	32	44	5	10	0–55 Claystone 55–85 Sandstone	50 53
Fraser Kenny	820720	416700	5183900	75	80	30	30	5	10	0–6 Sandy till 6–75 Fractured sandstone, claystone	35 40 60 70
Mc Millan Erskine	791020	416700	5184000	80	25	25	30	5	10	0–17 Clay till, claystone 17–80 Sandstone	40 43 70 73
Campbell Victor	711102	416900	5184000	70	55	20	21	5	15	0–3 Clay till 3–70 Fractured claystone, sandstone	40 45 64 67
Wilde Sterling	841200	417100	5184200	80	75	25	25	5	5	0–80 Claystone, sandstone	35 38 58 60
Doucette Wilbod	710723	417203	5184001	83	35	29	22	10		0–10 Clay till 10–80 Soft sandstone	
Meggison Wilbert	840407	417200	5184500	70	75		40	10	5	0–25 Claystone, sand 25–70 Gravel, claystone, sandstone	50 61 65 68
Gallant Fred	710525	417300	5184500	80	25	10	29	0		0–25 Clay 25–80 Soft sandstone	
Oliver John	720618	417300	5185894	92	105	51	30	5	15	0–12 Sand till 12–92 Fractured sandstone, sandstone	68 71 88 91
Carruthers Bruce	720525	417400	5184883	80	25	2	20	5	15	0–18 Clay till 18–80 Fractured sandstone, sandstone	35 38 58 58
Christopher Judy	770815	417500	5187000	70	80	10	29	5	10	0–14 Sandy till 14–70 Fractured sandstone, claystone	35 40 60 65
Butler Harvey	861015	417900	5184500	80	75	25	44	5	10	0–10 Clay 10–80 Sandstone	

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
Clark Erskine	770726	417800	5184800	73	30	25	21	5	10	0–10 Sandy till 10–45 Claystone, sandstone	30	35	60	70		
Ramsay Ronnie	781028	417900	5184400	72	60	19	25	5	10	0–5 Sandy till 5–72 Sandstone and claystone	30	33	65	68		
Morrell Perry	880914	417900	5184400	81	25	30	28			0–2 Clay 2–81 Sandstone and claystone	45	51	60	01		
Callaghan Earl	711214	417900	5185893	62	60	15	21	5	15	0–15 Clay till 15–62 Fractured sandstone, sandstone	40	43	53	01		
Cullicut Allison	781007	417912	5184903	67	35	15	22	10	10	0–22 Till 22–67 MDGD sandstone	35	38	57	60		
Pentecostal Church	700906	417920	5184500	60	30		21	5	15	0–60 Sandstone, sand	23	30	45	49		
Waite William	781008	417921	5184863	66	35	15	22	10	5	0–20 Till 20–66 MDGD sandstone	30	38	61	64		
O'Brian Allan	781103	418000	5184680	71	30	23	25	8	10	0–7 Till 7–71 Clay, soft sandstone, sandstone	45	59	62	67		
RPC Alberton Well 5	781105	418100	5184100	72	30	19	40	10	8	0–35 Clay till 35–72 Clay, sand, sandstone	41	44	60	63		
Coonts R P	781107	418100	5184100	73	30	21	35	10	8	0–34 Clay till 34–73 Clay, sand, sandstone	40	43	48	61		
RPC Alberton	781030	418100	5184100	71	50	21	30	10	8	0–25 Clay till 25–71 Clay, sand, sandstone	39	42	61	64		
RPC Alberton Well 1	781029	418100	5184100	73	50	21	30	10	8	0–35 Clay till 35–73 Sandstone	40	46	54	57		
West Prince Const	830602	418100	5184100	84	75	25	31		5	0–2 Clay 2–58 Sand, claysand, sandstone	42	45	57	58		
Low Rental Housing	851231	418100	5184100	86	25	20	41	10	10	0–10 Sandy till 10–86 Sandstone, some claystone	41	46	60	70	80	90
RPC Alberton	781106	418100	5184200	73	30	19	25	10	8	0–26 Clay till 26–73 Claysand, sandstone	37	40	52	56		
RPC Alberton Well 6	781109	418100	5184200	73	30	19	31	10	8	0–27 Clay till 27–73 Claysand, sandstone	36	41	54	57		
Campbell Robert	780902	418100	5184300	86	25	40	28	5	5	0–15 Clayey sand till	35	40	80	85		

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (kgpm)	Time (min)	Geology		Aquifers (Water Occurrences)					
										18–66 Sandstone, claysand							
O'Meares Heavy Equip	776711	418100	5184400	66	80	10	25	8	10	0–11 Sandy till		25	30	55	60		
										11–66 Sandstone							
Bonyman Russell	726666	418100	5184600	74	20	23	30	8	10	0–11 Sand till		35	40	65	70		
										11–74 Fractured sandstone, sandstone							
Alberton	726600	418100	5184700	70	25	12	20	8	10	0–10 Sand till		30	35	60	65		
										10–70 Fractured claysand, sandstone							
Osbourne Jim	726625	418100	5185100	80	75	13	20	70	8	0–80 Till		35	50	40	45		
										20–80 Sandstone							
Burke Margaret	726650	418100	5185600	75	80	15	24	10	10	0–0 Sandy till		40	45	60	70		
										0–75 Sandstone, some claystone							
Fraser Robert	726010	418100	5186404	66	80	15	21	8	15	0–7 Clay till		30	33	55	58		
										7–80 Fractured sandstone, sandstone							
Gotson Miles K.	751000	418101	5184101	67	35	17	22	10	10	0–21 Till		37	40	63	66		
										21–67 MDSD sandstone							
Low Rental Housing	660100	418100	5184100	90	23	27	40	10	10	0–10 Sandy till		40	45	80	70	89	90
										10–90 Sandstone, some claystone							
Mac Donald Howard	726010	418100	5186404	90	80	21	24	9	7	0–10 Till		31	37	84	84		
										10–43 Fractured sandstone, sandstone	SHDS						
ATO Property Ltd.	840602	418200	5182600	70	25	20	30	10	8	0–2 Clay		80	83	85	70		
										2–70 Sandstone, claysand							
ATO Property Ltd.	840731	418200	5182800	66	25	25	35	10	8	0–4 Clay		47	80	63	65		
										4–66 Sandstone, claysand							
ATO Property Ltd.	840602	418200	5182600	90	25	20	31	10	8	0–3 Clay		36	41	56	60		
										3–90 Claysand, sandstone							
Alberton Well 4	781100	418200	5184100	71	40	21	33	10	8	0–30 Clay till		45	48	51	54		
										30–71 Claysand, sandstone							
Alberton Well 3	781031	418200	5184100	70	80	21	36	10	8	0–36 Clay till		49	52	55	58		
										36–70 Claysand, sandstone							
ATO Properties Ltd.	830010	418200	5184100	75	50	25	30		5	0–2 Clay		53	56	72	75		
										2–75 Claysand, sandstone							
ATO Properties Ltd.	880710	418200	5184100	62	80	25	35			0–2 Clay		45	48	60	62		
										2–62 Sandstone and claystone							

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
Low Rental Housing	851218	418200	5184100	95	25	26	42	10	10	0–9 Sandy till 9–95 Sandstone, some claystone	80	85	90	95		
ATO Properties Ltd.	850715	418200	5184150	90	50	25	35			0–2 Clay 2–90 Sandstone and claystone	42	45	85	90		
Low Rental Housing	851113	418200	5184150	95	25	26	43	10	10	0–6 Sandy till 6–95 Sandstone, some claystone	80	85	90	90		
ATO Properties Ltd.	930616	418200	5184200	75	50	25	31		5	0–2 Clay 2–75 Claysand, sandstone	52	55	74	75		
Low Rental Housing	851221	418200	5184200	98	25	24	42	10	10	0–9 Sandy till 9–98 Sandstone, some claystone	80	85	90	90		
O'Meara Leo	791128	418200	5184900	51	25	20	32	5	5	0–9 Clay 9–51 Sand, claysand, sandstone	41	44	50	55		
Arthur Elmer	720822	418201	5185584	90	50	13	21	8	15	0–6 Sand till 6–90 Fractured sandstone, sandstone	24	27	86	91		
Arthur Elmer	720824	418201	5185584	90	50	5	17	8	15	0–6 Sand till 6–90 Fractured sandstone, sandstone	23	26	87	85		
Arthur Elmer	720823	418201	5185584	90	50	7	21	8	15	0–12 Sand till 12–90 Fractured sandstone, sandstone	25	31	90	89		
Arthur Elmer	720822	418201	5185584	90	50	8	19	8	15	0–9 Sand till 9–90 Fractured sandstone, sandstone	25	28	85	86		
Arthur Elmer	720826	418202	5185383	92	45	5	24	8	15	0–9 Fractured sand, sandstone 9–92 Fractured claysand, sandstone	25	31	90	91		
ATO Property Ltd.	840802	418240	5183900	90	25	25	33	10	5	0–3 Clay 3–90 Sandstone, claysand	41	44	84	89		
ATO Property Ltd.	840801	418250	5183900	90	25	25	35	10	5	0–3 Clay 3–90 Sandstone, claysand	41	44	85	89		
Low Rental Housing	851219	418250	5184200	95	25	24	39	10	10	0–9 Sandy till 9–95 Sandstone, some claystone	39	40	90	95	90	90
Arthur Elmer	720802	418299	5185183	91	50	4	27	8	15	0–24 Fractured sandstone, sandstone 24–91 Sandstone	22	25	87	90		
Arthur Elmer	720231	418299	5185483	92	45	17	21	8	15	0–11 Sandstone, till 11–92 Fractured sandstone, sandstone	20	31	87	90		
ATO Property Ltd.	930614	418300	5184100	78	50	20	32		5	0–3 Clay 3–78 Sand, claysand, sandstone	50	55	61	34	75	78

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (bpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
ATD Property Ltd.	820917	415350	5184200	88	80	80	35		5	0-2 Clay 2-80 Claysand, sandstone	40	51	60	63	70	80
Hoskett Harold	791018	415200	5185400	74	80	10	51	10	10	0-10 Sand till 10-74 Fractured sandstone, claysand	35	45	60	70		
Arthur Elmer	720820	415351	5185200	68	45	5	21	8	15	0-6 Sand till 6-68 Claysand, fractured sandstone	20	31	58	66		
Arthur Elmer	720910	415351	5185200	67	45	5	10	8	15	0-15 Sand, fractured sandstone 15-67 Sandstone	22	35	55	65		
Tremblay Joseph	730910	415302	5184790	60	35	9	35	10	4	0-10 Till 10-60 Claysand, MDGD sandstone	27	30	50	55		
Elodie Earnest	710705	415400	5183400	47	10	12	21	8	15	0-6 Clay till 6-47 Fractured sandstone, sandstone						
ATD Property Ltd.	820811	415400	5184100	85	80	80	35		5	0-2 Clay 2-85 Sandstone, claysand	40	43	60	61		
ATD Property Ltd.	820818	415400	5184200	83	80	35	34		5	0-2 Clay 2-83 Claysand, sandstone	60	55	65	60	82	85
Wooks Frank	790821	415400	5184400	74	35	30	31	7	10	0-12 Sand till 12-74 Fractured claysand sandstone	35	40	60	70		
Campbell Don	770525	415400	5184300	67	25	15	35	7	10	0-15 Sand till 15-67 Soft sandstone, sandstone	60	60				
Broderick David	801127	415400	5184800	80	80	25	32			0-2 Clay 2-80 Sandstone and claystone	41	44	48	50		
Pratt Bob	791025	415400	5184800	80	80	35	30	8	8	0-3 Clay 3-80 Sandstone, claysand	25	31	40	43	48	51
Arthur Elmer	721107	415400	5185195	80	35	7	23	8	15	0-15 Fractured sandstone 15-80 Sandstone	29	31	55	58		
Gallant Claire	790825	415400	5185200	69	30	15	29	10	10	0-9 Sand till 9-69 Fractured sandstone, claysand	35	40	55	65		
Butler Harvey	820811	415400	5185200	85	30	20	70	8	10	0-10 Clay 10-85 Claysand, f/c sandstone						
Pendergast Father	721113	415402	5184733	85	85	10	74	8	15	0-15 Fractured sandstone						

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrences)
										18–55 Sandstone	
Arthur Elmer	711117	418402	5185394	61	30	7	23	8	15	0–6 Clay till	23 59 66 66
										6–61 Fractured sandstone, sandstone	
Arthur Elmer	720603	418402	5185394	60	30	6	21	8	15	0–19 Fractured sandstone	23 31 66 61
										19–60 Sandstone	
Arthur Elmer	720606	418402	5185394	63	30	6	21	8	15	0–3 Sand till	23 31 60 63
										3–63 Fractured sand, sandstone	
Arthur Elmer	720606	418402	5185394	60	30	6	21	8	15	0–14 Sand till	23 31 66 61
										14–60 Fractured sandstone, sandstone	
Arthur Earnest	720609	418402	5185394	60	30	2	21	8	15	0–19 Sand	35 36 66 67
										19–60 Fractured sandstone, sandstone	
Arthur Elmer	720615	418402	5185394	66	46	2	13	6	15	0–10 Fractured sandstone	19 21 60 63
										10–66 Sandstone	
Arthur Elmer	720614	418402	5185394	64	46	6	24	8	15	0–19 Fractured sandstone	23 31 60 60
										19–69 Sandstone	
Arthur Elmer	720613	418402	5185394	60	46	6	23	8	15	0–19 Fractured sandstone	39 32 66 66
										19–60 Sandstone	
Arthur Elmer	720612	418402	5185394	62	46	6	34	8	15	0–22 Fractured sandstone	31 34 66 61
										22–62 Sandstone	
Arthur Elmer	720612	418402	5185394	60	46	6	21	8	15	0–17 Fractured sandstone	27 30 66 66
										17–60 Sandstone	
Haskell Russell	800711	418500	5183100	60	25	16	29	7	10	0–10 Sandy till	43 35 46 56
										10–60 Fractured sandstone, claystone ystone	
ATO Property Ltd.	830613	418500	5184100	65	50	20	31		5	0–2 Clay	35 36 42 46 66 65
										2–65 Sandstone, claysand	
ATO Property Ltd.	830620	418500	5184200	78	50	28	36		5	0–2 Clay	46 51 76 76
										2–76 Sand, claysand, sandstone	
Saunders Jerry	760427	418500	5184300	67	25	15	38	6	15	0–8 Clay till	40 43 60 66
										8–67 Sand, claysand, sandstone	
Alberton Museum	800606	418500	5184600	75	25	12	34	10	10	0–12 Sandy till	35 36 66 66
										12–75 Sandstone, shale, clay, claysand	
Campbell Robert	840915	418500	5184600	66	25	22	31	5	5	0–2 Clay	46 46 64 66
										2–66 Sand, claysand, sandstone	
Murphy Steven	850216	418500	5184600	66	25	22	33			0–3 Clay	42 46 64 66

Name	Date	East. (m)	North (m)	Depth (ft)	G.S Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
Dixon's Flooring	880423	418800	5184800	82	80	25	40			3–65 Sandstone and claystone 0–15 Sand and claystone 15–82 Sandstone and claystone	69	69	80	82		
McRae Art	810710	418800	5184700	80	85	19	50	5	5	0–4 Till 4–65 Claysand, sandstone	42	46	51	54		
Harper Reg	880827	418800	5184700	80	80	20	52			0–2 Clay 2–80 Sandstone and claystone	43	48	58	66		
Scott Georgia	820710	418800	5184900	90	80	30	32	5	5	0–2 Clay 2–90 Claysand, sandstone	30	33	43	48	86	58
Adams Lawson	720815	418800	5185194	81	85	5	34	5	15	0–22 Fractured clay, sandstone 22–81 Sandstone	29	32	57	60		
Gordon Allan	750825	418825	5184872	80	25	21	25	9	5	0–23 Till 23–80 MDGD, sandstone, claysand	52	36	46	48		
MacCarthy Wilfred	790815	418800	5182400	80	10	13	22	5	10	0–6 Sand till 9–80 Fractured sandstone, claysand	35	45				
Chevalier Gerald	800725	418800	5183200	63	25	11	51	10	10	0–19 Sandy shale 19–60 Shale, sandstone	40	43				
McDougall J. E.	800212	418800	5184400	60	80	30	30			0–3 Clay 3–60 Sandstone and claystone	39	38	42	48	86	60
Hardy Parley	791000	418800	5184800	86	80	36	25	5	5	0–10 Clay, sand 10–86 Sandstone, claysand	32	35	41	44	84	57
Arthur Michael	880125	418800	5184800	80	25	20	41			0–19 Sand and claystone 19–86 Sandstone and claystone	46	49	54	58		
Quigley Elizabeth	880215	418800	5184800	88	28	32	48			0–2 Clay 2–88 Sandstone and claystone	80	83	84	88		
Currie Bruce	880411	418800	5184800	87	25	20	38			0–2 Clay 2–87 Sandstone and claystone	45	48	54	57		
Alberton Fire Dept.	790810	418800	5184700	82	25	5	20	5	15	0–6 Clay till 6–82 Clay, sandstone	30	34	54	58		
Inman P + H	790105	418800	5184700	90	25	15	30	10	10	0–15 Sand 15–90 Sandstone, claysand	80	80	75	83		
Hutt Brian	790910	418700	5182300	80	10	30	25	5	5	0–6 Clay till	30	33	43	46		

Name	Date	East (m)	North (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)			
										3–50 Sand, clay, till, claysand				
Carpenter Dean	780507	418700	5184800	58	25		25	5		0–3 Clay	36	41	50	56
										3–58 Claysand, sandstone				
Gale Clifford	700505	418700	5184800	74	30	25	37	8	15	0–36 Clay, sand	40	43	68	66
										36–74 Hard sandstone				
Coughlin Wayde	780611	418700	5185100	60	30	30	29	5	5	0–15 Sand till	36	36	46	49
										15–60 Sandstone, claysand				
Perry John	720628	418702	5182293	54	15	7	24	5	15	0–5 Sand till	30	33	50	53
										5–54 Fractured sandstone, sandstone				
Hinch Alfred	700611	418720	5182560	21	25	5	21	5	15	0–15 Sand				
										15–21 Sandstone				
Begg Bill	780721	418723	5182292	60	25	9.5	23	9	9	0–21 Till	35	39	55	58
										21–60 Sandstone, some claystone				
Alberton Library	780515	418750	5184600	70	25	10	26	5	15	0–23 Sand till	38	40	60	66
										23–70 Sandstone				
Gallant Barry	800626	418800	5182100	60	25	20	34			0–2 Clay	40	43	46	50
										2–60 Sandstone and claystone				
Hinch Leo	790610	418800	5182600	60	25	21	24	5	5	0–15 Till	21	24	42	46
										15–60 Sandstone, claysand				
Matthews Herber	710610	418800	5182793	81	10	17	14	5	15	0–4 Clay till	15	19		
										4–81 Fractured sandstone, sandstone				
Horne Loughin	700604	418800	5184230	66	25	20	21	5	15	0–19 Sandstone, sand				
										19–66 Sandstone, claysand				
Broderick James	851211	418800	5184400	63	30	25	30			0–2 Clay	45	46	62	65
										2–63 Sandstone and claystone				
Zetland Lodge	800617	418800	5184800	75	25	29	36	10	10	0–36 Sand	46	45	65	70
										36–75 Sandstone				
Pridham Birt	830801	418800	5184800	66	25	25	56		5	0–20 Claysand, sand	50	56	64	65
										20–65 Sandstone, claysand				
Bennett Graham	850111	418800	5184800	66	25	25	36			0–36 Sand and claystone	50	53	63	66
										36–66 Sandstone and claystone				
Hudson Dale	800802	418800	5184700	62	25	25	30	5	5	0–25 Sand, claysand	42	45	60	63
										25–62 Sandstone, claysand				
Matthews Arthur D.	851211	418800	5184900	60	25	22	30			0–2 Clay	35	36	46	50

Name	Date	East (m)	North (m)	Depth (ft)	G.S. Elev (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
										2–50 Sandstone and claystone						
Richards Ken	710611	418800	5182500	62	10	10	17	5	15	0–4 Clay till	35	39	47	50		
										4–62 Fractured sandstone, sandstone						
Gallant Club	700620	418300	5182900	64	25	5	29	0	5	0–25 Till	32	36	51	54		
										25–55 MDGD sandstone						
Ramsay Amos	721010	418600	5182575	58	20	11	21	0	15	0–7 Clay till	25	32	50	55		
										7–58 Fractured sandstone, sandstone						
Albert, South School	700520	418520	5182600	62	15	12	10	5	10	0–2 Clay	25	31	47	50		
										2–58 FRDR sandstone, sandstone						
Boomoss George	700508	418540	5184750	60	25	10	27	5	15	0–20 FRDR sandstone, clay	50	55				
										20–60 Sandstone						
Perry John	700730	418570	5184500	60	25	20	25	5	15	0–24 FRDR sandstone, clay	29	31	54	57		
										24–60 Sandstone						
MacPhail David	700420	418554	5182504	121	100	55	55	10	5	0–10 Till	110	113				
										10–121 Sandstone, claystone						
Gallant Peter	701023	418300	5182800	40	25	25	25	5	5	0–7 Clay	35	35	—			
										7–40 Sand, sandstone, claysand						
Robinson Greg	001111	418900	5184000	74	25	24	32	10	10	0–9 Sandy till	30	40	60	70		
										9–74 Sandstone, some claystone						
Moffatt Woodbrad	700500	418800	5184200	58	60	31	29	5	7	0–6 Clay	38	41	53	56		
										6–55 Sand, claysand, sandstone						
Perry Eugene	700522	418900	5184400	74	23	25	31	12	10	0–19 Sand till	30	40	60	70		
										19–74 Sandstone, claysand						
Gordon Leigh	010606	418800	5184500	68	25	25	32	5	5	0–18 Claysand, sandstone	30	33	61	64	66	68
										18–68 Sandstone, claysand						
St Peters Ang. Rest.	700530	418900	5184800	74	25	25	42	15	10	0–11 Sand till	45	50	65	70		
										11–74 Fractured sandstone, claystone						
Barnett Claude	701113	418900	5184800	65	25	27	30	5	5	0–4 Clay	45	51	60	60		
										4–65 Sand, claysand, sandstone						
Crane Francois	701204	418800	5184800	60	25	32	43	10	10	0–25 Sandy till	45	50	50	55		
										25–60 Soft sandstone, claysand						
Harry Nelson	720627	418900	5184000	65	50	30	46	10	10	0–47 Soft claysand						

Name	Date	East (m)	North (m)	Depth (ft)	G.S. Elev (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
										47–65 Sandstone						
Avery Arnold	720621	418900	5184882	80	40	14	21	5	15	0–7 Clay till	55	35	57	60		
										7–80 Fractured sandstone, sandstone						
Cath. Parish Council	711230	418902	5183792	84	30	14	21	5	15	0–20 Fractured sandstone	27	30	60	65		
										20–84 Sandstone						
Arthur Elmer	720901	418903	5184793	72	36	22	24	12	15	0–6 Clay till	34	36	66	71		
										6–72 Fractured sandstone, sandstone						
Rockford Pat	710809	418904	5184483	80	35	13	21	5	15	0–10 Sand till	33	36	56	60		
										10–80 Sandstone						
Adams G. I.	880818	419000	5183300	80	75	40	42	5	10	0–10 Clay						
										10–80 Sandstone						
Adams G. I.	880821	419000	5183300	85	75	28	42	5	10	0–12 Clay						
										12–85 Sandstone, some claystone						
McLeod Hector	771107	419000	5185000	80		10	19			0–10 Clayey sand till	30	33	60	63		
										10–80 Hard BMRC						
Foley Robert	700808	419020	5183300	88	25	10	17	5	15	0–6 Clay	30	32	65	68		
										6–88 FRDR sandstone, sandstone						
Alberton Fisheries	710128	419080	5183750	300	25	10.7	47	70	24	0–10 Sand and clay	30	35	110	122	140	158
										10–300 Sandstone and claystone						
Fraser Roy	800818	419100	5183200	75	25	14	45	10	10	0–11 Sandy till	55	70				
										11–75 Claysand, sandstone, clay						
Alberton Fisheries	701201	419100	5183800	300		15	25	15	24	0–6 Sand, clay	55	65	70	75	85	95
										6–300 Clay, sandstone						
Flaminio Nick	711101	419100	5183802	90	20	0	21	5	15	0–6 Sand till	24	27	45	51		
										6–90 Fractured sandstone, sandstone						
Gavin Ralph	771208	419100	5183900	73	25	20	30	10	10	0–6 Sand till	35	40	60	70		
										6–73 Fractured clay, sandstone						
MacMillan Constr	850818	419100	5184800	97	25	28	33			0–15 Sand and claystone	30	35	65	67		
										15–97 Sandstone and claystone						
Kennedy Lee	770705	419100	5188800	88	25	24	32	5	10	0–17 Sand till	35	38	65	65		
										17–88 CMTD sandstone, sandstone						
Phillips Blanche	770722	419100	5189900	43	20	15	21	5	10	0–18 Sand till	35	40				
										18–43 Claysand, sandstone						
Gorin Reg	780617	419101	5183060	53	25	18	25	10	9	0–33 Sand till	31	35	50	52		

Name	Date	East. (m)	North. (m)	Depth (ft)	S.S. Elev (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
Doucette Albert	780810	410101	5183092	60	25	13	20	10	5	0–25 Sand till 25–60 Claysand, sandstone	20	33	50	55		
Sherry Edith	730905	410150	5183091	67	5	13	27	5	15	0–5 Clay till 5–67 Fractured sandstone, sandstone	34	37	55	60		
Foley John	730910	410155	5183092	60	20	17	21	5	5	0–14 Sand till 14–60 Fractured sandstone, sandstone	20	39	45	46		
O'Brien John	710705	410155	5184081	60	30	12	31			0–11 Clay till 11–60 Fractured sandstone, sandstone	22	35	47	50		
Graham Allen	771155	410155	5184509	30	20	12	12			0–12 Sand, clay, till 12–30 SMRC	10	15	25	30		
Cotthoff Dennis	660527	410550	5184509	64	50	20	31			0–2 Clay 2–64 Sandstone and claystone	31	33	43	48	60	64
Henderson Robert	630125	410550	5185010	45	25	10	24	5	5	0–1 Clay 1–45 Claysand, sand, sandstone	30	41	44	45		
Low Rent Housing	790720	410550	5184152	73		10	32	5	10	0–11 Sand till 11–73 CMID sandstone, sandstone	56	60				
Low Rental Housing	790725	410550	5184152	73		10	31	5	10	0–11 Sand till 11–73 CMID sandstone, sandstone	55	60				
Low Rental Housing	790726	410550	5184150	73		10	32	5	10	0–10 Sand till 11–73 CMID sandstone, sandstone	55	60				
Low Rental Housing	790727	410550	5184152	73		10	31	5	10	0–10 Sand till 10–73 CMID sandstone, sandstone	55	60				
Low Rental Housing	790728	410550	5184155	73		10	31	5	10	0–9 Sand till 9–73 CMID sandstone, sandstone	55	60				
Low Rental Housing	790729	410550	5184155	73		10	31	5	10	0–9 Sand till 9–73 CMID sandstone, sandstone	55	71				
Low Rental Housing	790732	410550	5184152	73		10	32	5	10	0–10 Sand till 10–73 CMID – hard sandstone, claystone	20	53	55	60		
Low Rental Housing	790731	410550	5184152	73		10	20	5	10	0–11 Sand till 11–73 MDGD– hard–CMID sandstone	20	53	55	60		
Hokpo A	780813	410400	5186410	60	35	8	22	10	5	0–21 Till 21–60 Sandstone	25	35	35	36	52	55
Maloney BJ	780805	410400	5187300	60	50	35	22	5	10	0–3 Clay	31	34	45	46		

Name	Date	East (m)	North (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (gpm)	Time (min)	Geology	Aquifers (Water Occurrence)					
										3–80 Sand, claysand, sandstone					
Wells Edward	800908	419500	5186700	80	50	13	30	15	10	0–9 Clay till	45	58				
										9–80 Sandstone, claysand, frac. sandstone						
Maloney Barry	840525	419500	5187400	56	60	20	20	10	5	0–2 Clay sand	40	43	55	56		
										2–56 Sandstone, claysand						
Arthur Elmer	711025	419500	5185194	62	20	17	21	5	15	0–4 Sand till	20	29	57	60		
										4–62 Fractured sandstone, claystone						
Arthur Elmer	711022	419500	5185194	57	20	8	21	5	15	0–6 Clay till	23	30	52	55		
										6–57 Fractured sandstone, sandstone						
Micheal Kinch	780803	419500	5186094	55	25	20	25	5	10	0–8 Sand till	20	33	55	58		
										8–55 Hard sandstone, sandstone, claystone						
Weeks Frank	780602	419500	5186300	58	25	20	22	7	10	0–11 Sand till	20	35	50	55		
										11–58 Claysand, sandstone						
Arthur Elmer	711020	419501	5185294	61	20	8	19	5	15	0–4 Clay till	24	27	57	60		
										4–61 Fractured sandstone, sandstone						
MacMillan Clarence	780706	419500	5186900	57	60	35	25			0–15 Clay, sand till	24	27	46	45	55	57
										15–57 Sandstone, sand, claysand						
		Averages		66		19	30	9								

APPENDIX II

WATER QUALITY DATA

APPENDIX II
Water Quality Analyses

ALBERTON

Name&Date		Easting/Northing	Parameters Ca	Mg	Na	K	Hard.	Alk.	Cl	SO4	P	NO3	pH	Fe (T)	Fe (D)	Mn	Cd	Cu	Cr	Ni	Pb	Zn
Chester Adams	000006	410000/5100000	10.2	11.00	0.7	1.02	91.0	82	14		0.11	2.0	8.0	<0.1	<0.1	<0.02		0.00			<0.1	0.14
Charles Ashley	001117	417200/5104000	10.7	0.00	10.4	0.53	97.7	74	20		0.10	0.0	7.0	0.0	<0.1	<0.02		0.07			<0.1	0.00
Charles Ashley	040015	417200/5104000	40.0	10.07	0.2	0.20	179.7	134	17		0.00	0.0	7.5	<0.1	<0.1	0.00		<0.00			<0.1	0.40
Ray Bell	000000	410000/5104170	20.2	10.00	0.0	1.02	144.5	110	27		0.24	0.0	7.5	<0.1		<0.02		0.02			<0.1	0.10
David Brodaniuk	000400	410100/5104700	20.0	0.10	0.5	1.20	97.5	70	20		0.04	2.5	7.5	0.2	<0.1	0.04		<0.02			<0.1	0.00
Bob Campbell	070421		10.0	11.40	14.0	2.27	94.7	00	20		0.00	2.3	0.0	0.4	<0.1	0.04		0.00			<0.1	0.00
Irvin Campbell	010002	421000/5100000	27.0	0.00	0.0	1.20		110	0	0	0.10	0.4	7.5	0.2	<0.1	0.20		<0.00			<0.1	0.20
Bruce Curle	021000	410000/5104000	20.7	22.00	10.7	2.20	100.0	204	44	10	0.00	2.0	7.0	0.1	<0.1	0.02	<0.00	0.00	<0.00	<0.00	<0.1	0.14
Kevin Dunnville	040012	410400/5104000	24.0	10.07	11.0	4.40	117.0	100	10		0.00	1.7	0.0	<0.1	<0.1	<0.02		0.02			<0.1	0.10
Bruce Gallant	071027	410000/5104400	0.0	2.00	00.0	2.40	20.2	141	10		0.00	1.5	0.0	<0.1	<0.1	<0.02		<0.02			<0.1	<0.02
Dr. S. Hollotah	000010	410000/5104000	10.2	12.02	11.0	1.02	00.0	100	10	0	0.10	2.0	7.0	<0.1	<0.1	<0.02	<0.02	0.07	<0.00	<0.00	<0.1	0.17
Eric S. James	041210	410000/5104100	42.0	17.00	14.0	2.17	104.4	104	10		0.12	1.0	7.0	<0.1	<0.1	<0.02		0.04			<0.1	0.00
Kildare R. Pond	070714		40.7	00.00	1200	20.00	407.0	70	1000		0.00	<0.2	0.5	<0.1	<0.1	0.04		<0.02			<0.1	<0.02
Sandra Larter	021000	410000/5104000	27.0	22.00	10.0	2.14	100.0	100	01	11	0.00	1.0	0.2	0.1	<0.1	0.00	<0.00	<0.02	<0.00	<0.00	<0.1	0.10
D. McCarthy	021112		17.1	7.00	0.5		75.5	75	13		0.12	0.5	7.0	<0.1	<0.1	<0.02						
Bert Pridham	020025	410000/5104400	20.1	14.03	17.5	4.41	140.0	140	10	10	0.00	0.2	7.5	3.2	<0.1	0.01		0.00			<0.1	0.40
Francis Smith	000011	410000/5104000	20.2	12.10	4.1	1.77	121.0	70	11		0.07	1.0	0.0	<0.1	<0.1	<0.02		0.00			<0.1	0.40
Francis Smith	000001	410000/5104000	21.0	10.40	7.0	1.04	100.1	00	10		0.00	1.0	7.5	<0.1	<0.1	1.12		0.10			<0.1	0.20
Westomer Motel	010720	417100/5104300	20.0	10.00	13.0	1.00	111.0	00	40	0	0.00	1.0	0.0	0.3	<0.1	<0.02		0.10			<0.1	0.20
Westomer Motel	001104	417100/5104300	20.0	10.05	10.1	1.02	00.0	00	10		0.00	1.4	0.0	<0.1	<0.1	<0.02		0.20			<0.1	0.22
G.Wilde (W)	000710	417200/5104000	10.0	7.47	7.0	1.00	70.5	72	11	4	0.17	0.5	7.7	0.2	<0.1	0.02	<0.02	0.12	<0.00	<0.00	<0.1	0.70
G.Wilde (H)	000710	417200/5104000	42.0	10.40	14.5	0.20	100.1	107	20	14	0.10	0.3	7.4	<0.1	<0.1	<0.02	<0.02	0.27	<0.00	<0.00	<0.1	0.40
Hospital	010722	410000/5100100	20.0	7.00	0.0	1.70	02.0	01	10	7	0.00	1.7	0.1	0.2	<0.1	0.00		0.20			<0.1	0.20
Hospital	041010	410000/5100100	10.0	0.00	7.5	1.07	01.5	00	10		0.12	1.3	7.0	0.2	<0.1	<0.02		<0.02			<0.1	0.20
Hospital	000011	410000/5100100	20.0	7.00	0.4	1.00	02.4	03	12		0.00	2.1	7.0	<0.1	<0.1	<0.02		0.10			<0.1	0.72
Hospital	001104	410000/5100100	17.7	0.00	0.3	1.07	01.5	00	11		0.05	1.0	7.0	<0.1	<0.1	<0.02		0.02			<0.1	0.02
Senior Ctr.	010722	410020/5104020	10.0	0.40	7.0	1.70	02.0	01	0	0	0.00	0.4	0.2	0.1	<0.1	0.04		0.10			<0.1	0.20
Br Ctr.- A (C)	041213	410020/5104020	20.2	14.02	11.2		124.0															
Br Ctr.- A (H)	041213	410020/5104020	7.0	0.40	70.0		20.1															
Br Ctr.- B (C)	041213	410020/5104020	24.0	11.70	7.0		110.7															
Br Ctr.- B (H)	041213	410020/5104020	1.0	0.03	02.0		0.7															

Name&Date	Easting/Northing	Parameters																		
		Ca	Mg	Na	K	Hard.	Alk.	Cl	SO4	P	NO3	pH	Fe (T)	Fe (D)	Mn	Cd	Cu	Cr	Ni	Pb	Zn
Sr Cit.– B (C)	660600	4166300/6164520	24.0	11.98	8.4	1.02	106.0	86	14		0.16	1.8	7.8	<0.1	<0.1	<0.02		0.02			<0.1	0.13
Senior Cit.– C	660600	4166000/6164300	21.0	12.10	7.7	1.02	103.0	84	15		0.10	2.0	7.8	<0.1	<0.1	0.02		0.03			<0.1	0.33
Elementary Sch.	661000	4173300/6164650	17.0	7.40	6.0	1.00	72.0	62	12	5	0.02	0.5	8.0	0.2	<0.1	<0.02		0.06			<0.1	0.14
Elementary Sch.	660220	4173300/6164650	20.8	8.41	6.7	1.34	80.0	64	10		0.10	0.5	7.9	<0.1	<0.1	<0.02		0.04			<0.1	0.48
Elementary Sch.	660204	4173300/6164650	20.2	10.11	7.3	1.26	82.0	62	10		0.07	1.1	7.8	<0.1	<0.1	<0.02		0.03			<0.1	0.46
	CDWS								250	500		10.0	6.5–8.5	0.3		0.05	0.005	1.00	0.05		0.05	5.00